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THE EFFECT OF ETHIOPIAN ADULT MALES BODY SHAPE ON THE CREATION OF A STANDARDIZED SIZE MAP

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ABSTRACT

The size chart standardization has recently gained prominence in the readymade garment industry in the backdrop of rising manufacturing costs resulting from ill-fitting garments, consumer returns and mass customization. This problem of unfit garments is even more pronounced in the African subcontinent, particularly Ethiopia, where measurement of human body dimensions has been given limited attention, even though they are significantly different from others. The objective of the present study was to develop standardized measurement charts for Ethiopian men in the age group of 25-55 years. Anthropometric database was collected from a large cross section of 9158 male staff serving the Government owned single largest telecom company, Ethio Telecom, from across all the 17 locations of Ethiopia. After thorough clean-ing of data, Outliers were identified by using Rosner's test and were replaced with blank or NAs. Additive regression, bootstrapping, and predictive mean matching algorithms available in 'Hmisc' package of R software was used to impute missing data or outliers. Multivariate data analysis technique called Principal Component Analysis (PCA) and clustering technique, K-Means was used. PCA was carried out with equamax rotation or varimax rotation to iden-tify two of the most predominant underlying components or variables. Abdominal Girth, Chest Girth and Neck Girth showed the highest factor loadings as 0.791, 0.736 and 0.73 respectively with the girth component, while Inseam, Pant Length, Full Front Length and Height witnessed the highest factor loadings as 0.717, 0.708, 0.695 and 0.583 respectively with the length component.

Key word: standardization, manufacturing, customization, Ethiopian

INTRODUCTION

Innovations in manufacturing designing to improve product quality and decrease the final cost have been given increased focused in recent years (Fontana et al., 2006; De Toni & Meneghetti, 2000). One of the major problems which many consumers face in mass-produced clothing is their inability to find good fit. Customers are attracted to-wards fashionable and high-quality garments, which can fit them comfortably fit and makes them feel good. Therefore, fit can be perceived as an important contributor to make quality garments. The requirements or elements of fit are commonly categorized as 'ease', 'line', 'grain', 'balance' and 'set'.

Anthropometric Studies

Anthropometric studies are associated with the recording as well as the collection of body dimensions of subjects based on test selection. In an Anthropometric study, 311 women studying in the London College of Fashion were measured. This was taken on to supply updated information on the body measurements of young women planning to make fashion their career. The example was extracted from the whole trainee population of the London College of Fashion. The outcomes related to 311 subjects, and the age distribution in single year classes; the age variety was slim, simply over 71 % being either 18 or 19 years old. In ethnic origin, 92% of the example was European. Despite this proof of diversification there seemed no reason to exclude the non-European since the sample was typical of many modern student populaces in Western Europe.18 body measurements were taken as well as the outcomes were given up terms of array, the mean as well as standard inconsistency for every variable. A relationship matrix was computed for all the variables and the research was finished by element analysis. The relationship was contrasted to an earlier work by Kemsley in 1957. The outcomes were similar in terms of variable analysis and loadings as 6(six) variables represented 82% variability.

A specially developed computer program arranged subjects by dimension based upon the same breast, elevation, and weight requirements as those made use of in the PS 42-70 database. For the analysis, subjects were categorized right into 7 figure types (Junior Petite, Junior, Misses Petite, Misses Tall, Women and Half Size in 6-10 dimensions each. Making use of t-tests compared mean

differences of each size within each figure type. Significant differences between the present older women's body measurements and the PS 42-70 database throughout the sizes andfigure types were abdominal-extension, waist, and sitting spread, armscye, bust-height, back size, breast hip, hip and hip arc. Some dimensions (e.g. hip height, inseam, cervical-height, waist-arc, abdominal arc as well as weight) tended to be normally greater than those of the PS 42-70 with a couple of exceptions in some figure types. Relying on the sizes as well as number types, other dimensions varied in both instructions from the PS 42-70. It could be expected that women 55 and older would certainly have problems purchasing apparel that fitted well. Thus, it was critically crucial that the new database is used to create improved sizing for women 55 and older.

Sizing studies

He following studies reported are pertaining to fit issues, which are very specific and done with a purpose to either identify a fit problem or to find a solution for the existing fit problem. Some of the studies here are based on older anthropometric surveys in order to compare with the recent global surveys. A research was performed by the Bureau of Home Economics took fifty-five measurements of numerous thousand women. Partial correlations with age held constant were calculated for a depictive group of 4,128 of the women. The correlations amongst twenty-nine of these variables acted as the basis of the study carried out by (Heath, 1952). By a combination of the multiple-group and the centroid technique of factoring, five factors were extracted. After twenty-nine rotations, the simple framework appeared, as well as the factors were taken bone length, size of joints, as well as circumference below the waist, the circumference of extremities, and circumference above the waist. The intercorrelations of the primaries were computed, as well as 2 second-order factors were extracted. It was found that of them was primarily related to the development of fat as well as the various other to the advancement of the bones.(Salusso-Deonier, 1984)The researcher found variations within height intervals along a linear-to-lateral body type continuum. To be adequate, PS 42-70, the standard currently used in the United States should be precise as a classification system for body type variation, easily used within the apparel production process, as well as understandably labeled. A sizing system is based on the database as well as method utilized to structure body type variation in that database. The database for this study was the 1977 survey of the 1330 U.S.A Military females with 60 measurements per subject. Subjects

differed in body size, regional distribution, race and age. After discriminate evaluation of race and age effects, the example was restricted to subjects who were White or Black and in between 17 -35 years old. A review of the apparel sizing, body form classification as well as multivariate statistics generated classification methodologies relevant to classification of body type variation.

Preliminary assessment of PS 42-70 as a classification system for the sample revealed poor proportioning of lengths as well as upper body breadths. Fifteen principal components were utilized to summarize patterns in body form variation. Principal components 1 as well as 2, laterality (fullness) and linearity (length) were chosen to define body dimension as well as type. Parallel cluster analyses of variation within classifications specified by laterality and linearity components and categories defined within the PS42-70 showed lower body laterality and upper body linearity to be common variations among teams uniform in general size.

The experimental technique was developed around relationships in between the size of laterality and linearity components. The Principal Component Sizing System, PCSS resulting from this method structured variation within height intervals along a linear-lateral type of body continuum. Quantitative and qualitative comparisons of PS 42-70 and PCSS as classification systems showed the later to be numerically much more efficient as well as appropriate.

By using the proposed technique, body shapes could be accurately identified to develop body measurement charts. The population was identified into 3 stature categories and 4 body shapes as well as brand-new measurement charts were developed.(Kim & Park, 2007)offered a new method to create fundamental patterns of different sizes and styles employing three-dimensional geometric modelling technique. The geometry of a garment was split into the fit zone and the fashion zone. The geometry of the fit zone was prepared from 3 D body Scan data to make sure that its shapes and size might be customized in a parametric manner. The fashion zone was modeled employing different parameters characterizing the aesthetic look of garment silhouette to ensure that the customers could develop different garments with ease. Database monitoring system for garment shape templates was developed to make sure that the users might create different garments ranging from standard items to expensive things. Flat pattern forecast algorithm was developed to make

level patterns considering the physical residential or commercial properties as well as producibility of garments.

MATERIALS AND METHODOLOGY

Sample selection and size determination

The Ethiopian subcontinent is divided into 10(ten) major regions, viz. Addis Ababa, Affar, Amhara, Benishangul-Gumuz, Dire Dawa, Harari, Oromia, S.N.N.P, Somali and Tigray. The single largest and Government-owned telecom company, Ethio Telecom is spread acrossall the regions of the country. As reported by the company, the male staffs for whom the uniforms were to be designed, fell under the age group of 22-55.The total urban-rural male population of Ethiopia falling in the age group of 22-55 as per the last published census, 2007 was 1,00,18,834. 9158 male Ethio Telecom staffs from the target category working across the nation were identified. Their anthropometric dimensions were collected by a large team ap-pointed by Ethio Telecom who were spread across the country. A total of 2684 individuals were selected randomly from a total of 9158 by using stratified random sampling for the sake of heterogeneity in the sample. 30% of the observations from each of the 17 locations were randomly selected. A total of 10 girth and 11 linear measurements were taken from the subjects.

Collecting, Preparing and Checking the Dataset

The sizing variables or control dimensions required for the anthropometric data was generally referred from ISO. The sizing variables used for male garments are typically height, chest girth, and waist girth. Data collected are subdivided into linear and girth measurements.

Coding of individuals and locations

Since anthropometric data were received from 17 different locations across Ethiopia, it was necessary to code the individuals and the locations from where they belonged to. This was also done because; the objective was to 'allocate' their 'best fit' sizes them be-longed to.

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Identification and treatment of outliers

Outliers were identified by using Rosner's test (Rosner, 1983). There are many tests for identification of outlier's viz. Dean-Dixon test, Walsh test, Grubb's test, Nalimov test etc. The reason for using this test was that this test has been "designed to avoid the problem of masking, where an outlier that is close in value to another outlier can go un-detected". Rosner's test is appropriate only when the data, excluding the suspected out-liers, are approximately normally distributed, and when the sample size is greater than or equal to 25.

Replacing outliers and missing data with Nas

The researcher created algorithms to locate the outliers and replaced them with blank or NAs. The missing data were identified and replaced with NAs. This is a necessary step before any computation.

RESULTS AND DISCUSSION

Performing Rosner's test Rosner test was done so that the final chart was not affected by the outliers and could cover a large part of the population as shown in Table and chart.

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Variables sorted by number of missing values	
Variable	Percentage
FFLNGTH	55.8%
PNLNGTH	42.5%
HP	40.3%
CHST	32.9%
AB	26.5%
WST	25.0%
WT	20.6%
HT	14.9%
CL	13.9%
BCP	12.8%
THGH	12.5%
LSL	12.0%
AHC	11.6%
SHLDR	11.4%
INSM	11.2%
BL	10.9%
NK	10.5%
FL	10.0%
WRST	9.1%
SSL	7.9%
ANKL	6.8%
CD	6.2%

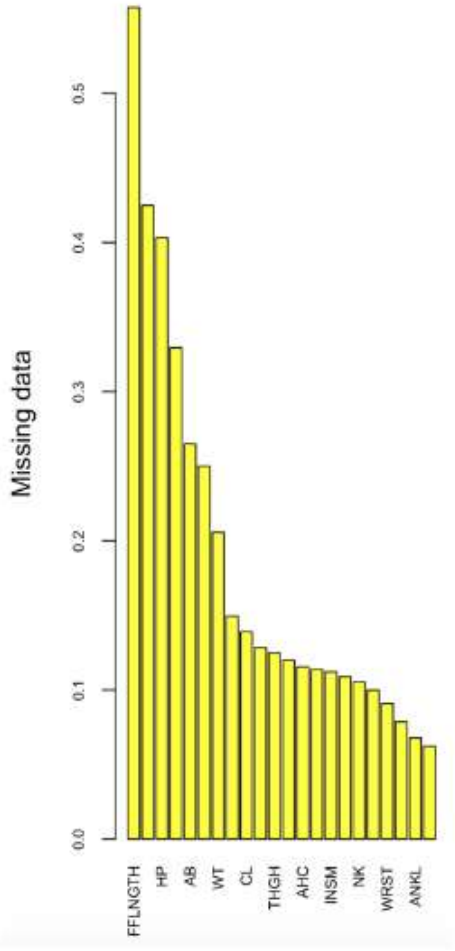

Table: 1 Rosner's test

Replacing outliers and missing data with Nas

Since the data received had large number of outliers, it was not advisable to remove the observations containing them out rightly as it would have reduced the total number of observations to be used for the analysis. Therefore, the researcher created algorithms to locate the outliers and replaced them with blank or NAs. The missing data were identified and replaced with Nas.

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Imputing NAs with mean values using advanced algorithms

Then the researcher used additive regression, bootstrapping, and predictive mean matching (PMM) algorithms to impute the NAs. 'aregImpute' algorithm from the Hmisc package in Rwas used. The output in Table 2 shows R^2 values for predicted missing values. Higher the value, better are the values predicted.It can be noticed that 14 out of 22 body measurements have R2 values more than 0.5 which is good.

n: 2683 p: 22 Imputations: 5 nk: 0

Number of Nas									
NK	SHLDR	CHST	FL	BL	AB	WST	HP	LSL	SSL
419	382	913	284	286	787	676	1224	388	261
BCP	AHC	WRST	PNLNGTH	INSM	THGH	ANKL	CD	CL	FFLNGTH
357	335	635	1176	309	326	342	486	398	1456
HT	WT								
388	556								

R-squares for Predicting Non-Missing Values for Each Variable									
Using Last Imputations of Predictors									
NK	SHLDR	CHST	FL	BL	AB	WST	HP	LSL	SSL
0.576	0.379	0.657	0.932	0.95	0.752	0.716	0.534	0.314	0.239
BCP	AHC	WRST	PNLNGTH	INSM	THGH	ANKL	CD	CL	FFLNGTH
0.686	0.474	0.423	0.526	0.581	0.507	0.46	0.147	0.347	0.625
HT	WT								
0.644	0.686								

(where p = Number of categorical variables)

Table-2: R2 Values for predictedmissing values

Histogram for all the body dimensions was generated to pictorially represent the dis-tribution of data. It can be noticed that except, Chest, Pant Length and Waist, all the other dimensions are normally distributed from the figure.

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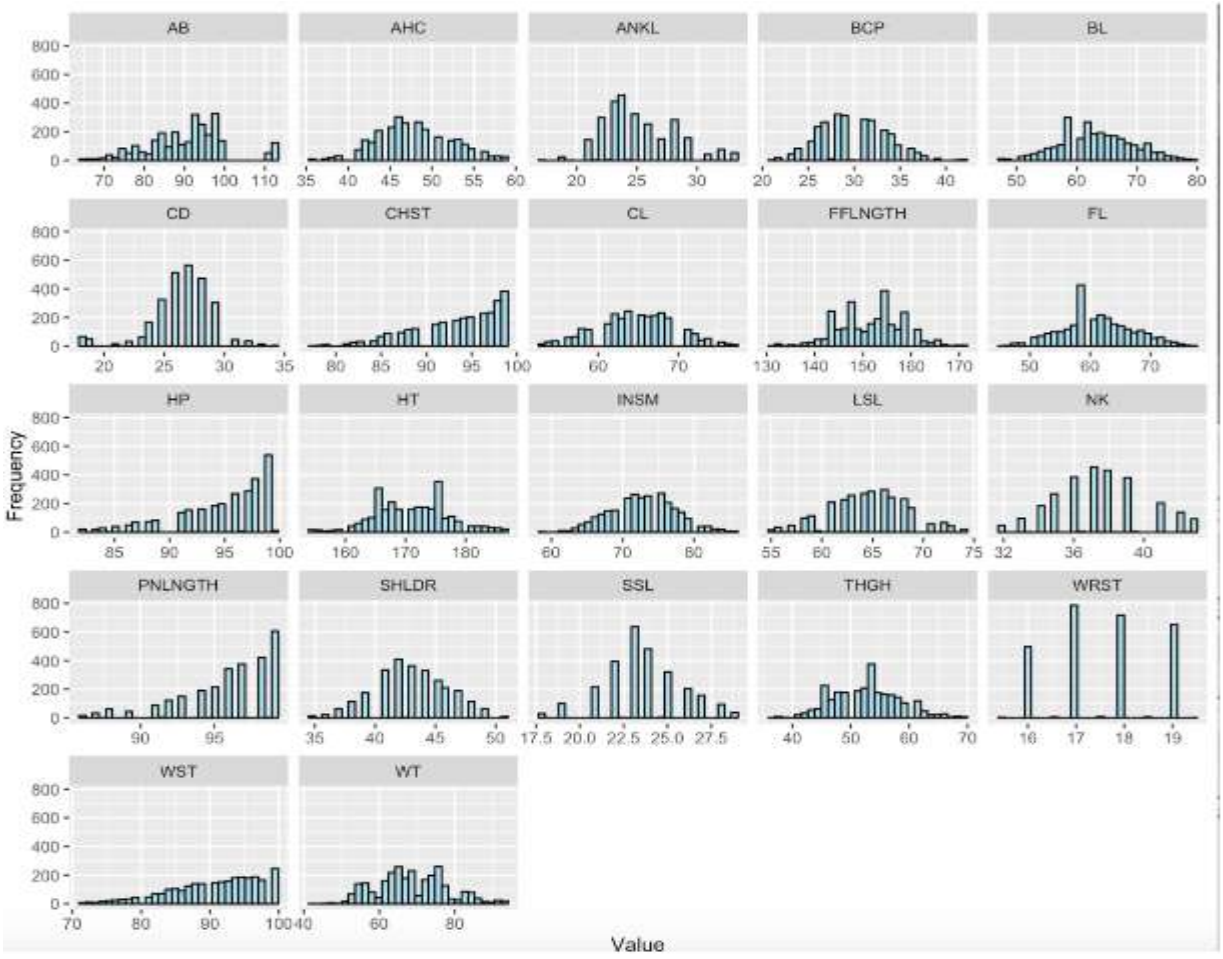

Figure: 1 Histogram of body measurement distribution

Multivariate analysis

Bartlett's test of sphericityBartlett test was used to check if it is an identity matrix which would indicate that the variables are unrelated and therefore unsuitable for structure detection. Smaller values, lesser than 0.05 of the significance levels indicates that a factor analysis may be useful with the data

The P-value was found to be very less < 2.22e-16.
The value of X2(chi-square) was found to be 37600.435 with df = 231.
This indicated that a factor analysis was useful with the data.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy

KMO test was conducted to indicate the proportion of variance in the variables that might be caused by underlying factors. The results were very encouraging as shown in Table.

NK	SHLDR	CHST	FL	BL	AB	WST
0.93566	0.93851	0.950938	0.727947	0.728654	0.888015	0.882825
HP	LSL	SSL	BCP	AHC	WRST	PNLNGTH
0.94427	0.851229	0.817175	0.930595	0.962895	0.884141	0.778595
INSM	THGH	ANKL	CD	CL	FFLNGTH	HT
0.75183	0.890089	0.836787	0.724398	0.888452	0.853241	0.826488
WT						
0.92997						
KMO-Criterion: 0.8718996						

TABLE 3 : KMO TEST

Analyzing internal reliability using Cronbach's Alpha Reliability Coefficient

the value of Cronbach's alpha, α (orcoefficient alpha) was 0.8764957 which was encouraging as per the following rules of thumb(George & Mallery, 2003):

i.> .9 –Excellent
ii.> .> .8 –Good
iii.> .> .7 –Acceptable
iv.> .> .6 –Questionable
v.> .> .5 –Poor, and
vi.> .< .5 –Unacceptable

CONCLUSIONS

i. A total of 2684 individuals were selected randomly from a total of 9158 by us-ing stratified random sampling for the sake of heterogeneity in the sample.i.All length measurements appeared to have good correlation among themselves and all girth measurements had good correlation with each other.

ii. There was a poor correlation among the length and girth parameters.

iii. Five key body dimensions (shoulder, neck, height, chest and hip) had good correlation with maximum of other dimensions. Shoulderhadmild to strong correlation with 14 other body dimensions; Neckhadmildto strong correlation with 13 other body dimensions; Heighthadmild to strong correlation with 12 other body dimensions; Chesthadmild to strong correlation with 11 other body dimensions; and Hiphadmild to strong correlation with 10 major linear body dimensions.

iv. From the findings, it was found that shoulder and chest measurement for the upper body and hip measurement for the lower body garments are the most critical measurements.

v. PC1 showed that biceps, abdominal girth, and neck has factor loadings more than 0.7, whereas PC 2 showed that full length, height and inseam has factor loadings more than 0.7.

vi. Abdominal Girth, Chest Girth and Neck Girth showed the highest factor load-ing as 0.791, 0.736 and 0.73 with respect to the girth component.

vii. In the length components, Inseam, Pant Length, Full Front Length and Height witnessed the highest factor loading as 0.717, 0.708, 0.695 and 0.583 respectively.

FUTURE SCOPE OF THE WORK

Unlike other countries, it was found that there is considerably scanty work done in the area of size standardization in Ethiopia, especially using a large sample size. There-fore, the researchers realize that there is a huge scope of extending this work to other gender and age group. With the advent of rapidly growing technology, more advanced tools like 3D body scanning can be employed for more accurate anthropometric data. This would pro-duce better and more accurate sizing charts.

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